ENVIRONMENTAL QUALITY MANAGEMENT, INC.

MEMORANDUM

To: Eric Bowman **Date:** April 10, 2012

Subject: Springfield Belle System Review **From:** John Wentz, PE

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Mark Douglas
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This memorandum has been prepared to summarize the results of the site visit to the Environmental Quality Management, Inc. (EQ) Hammond, IN office where a preliminary assessment of the Springfield Belle mobile wastewater treatment system was performed.

Listed below are the four primary objectives of the preliminary assessment:

1. Review the flow diagram against actual configuration and identify any discrepancies.
2. Review the system against the following lists provided by US EPA:
   a. "Repairs List for Springfield Bell", August 12, 2011
   b. "Issues Encountered in Springfield Belle Start-Up", June 2011
3. Review the system to determine best method for providing recycle water loop for system test out purposes.
4. Review the system to see if any upgrades could be recommended for:
   a. Improvements for overall operations
   b. Make the SB suitable for use at Portage Creek for treatment of accumulated water on the soil staging pad.

The following provides the findings of the site visit:

1. Review the flow diagram against actual configuration and identify any discrepancies.

The SB treatment system was reviewed in comparison with the Process Flow Diagram PFD and process description as provided in the Operations & Maintenance Manual (O&M Manual), dated June 1999 as prepared by TIGG Corporation of Pittsburgh, PA. The flow identified in the PFD and the process description differed per the following.

- The PFD shows the flow through the Bag Filter, directly into the Sand Filter, Organo-Clay, and/or Adsorbers (multiple configuration capable) and does not show the Surge Tank or Pressurization Pump (P3). From the observations, the system can be configured so that flow from the Bag Filter Housing can go directly to the Sand Filter, Organo-Clay and/or Adsorbers or it can be configured so that flow from the Bag Filter can be directed into the Surge Tank where the Pressurization Pump P3 pumps the flow out to the treatment system. The flow into the Surge Tank is preferred over the direct flow from the bag filter into the adsorbers.

2. Review the system against the following lists provided by US EPA: "Repairs List for Springfield Bell", August 12, 2011 and "Issues Encountered in Springfield Belle Start-Up", June 2011.

Copies of the two documents are attached for reference. The following reiterates each item from the lists, then provides the findings from the system review.

1. "Backwash pump flow meter needs repair or replaced (does not read correctly/sometimes not at all)."
2. "Backwash pump flow rate needs to be checked, pump may need replacement. (pump needs to maintain 120 gpm to backwash vessels at 40' TDH (17.3 psi)."

Response to Items 1 & 2 as they relate to the Backwash pump and flow meter.

- The Backwash Pump should provide 120 gpm at 40' TDH (17.3 psi) per the O&M Manual.
- The Backwash Pump and the backwash flow meter are both in question. In order to verify both, it will be necessary to utilize a flow meter that is known to provide accurate flow indication. It is suggested that a clamp on style transient time flow meter be rented for the purposes of the test out. These are non-intrusive meters that can be readily relocated and reused for the purpose of the overall system test out described later in this document.
- The flow meter in question was removed from the pipe and observed.
    - The flow meter is a Signet Scientific paddle wheel style, Model MK509 inserted in the special tee for paddlewheel flow meters. The pipe is 3" PVC schedule 80. There appeared to be adequate upstream and downstream straight length pipe for proper operation of the meter and the meter was located in a low point of the piping in a horizontal flow, thus assuring full flow in the pipe. The meter was installed 90º from the vertical. The paddlewheel was free from debris and buildup and spun freely. From the observation, there was no evidence that would indicate the meter would not operate properly.
- During the test out, the temporary flow meter will have to be installed on the straight length pipe after the existing paddle wheel flow meter.
    - System will be configured so that Backwash Tank is full, piping/valving is configured to draw from Backwash Tank, through the Backwash Pump and through the backwash piping (recommended to test the sand filter, organo clay, and two carbon vessels on an individual bais) and return the water to the Backwash Tank for recirculation purposes.
    - The pump will require operation and the current, voltage and amperage checked against the pump specification. If these are not to specification, electrician may need to perform electrical troubleshooting.
    - The pump will be operated and the pressure on the pressure gauge at the pump discharge will be observed. Pressure should be at 17 – 17.5 psi and flow at 120 gpm.
    - The reading from the paddle wheel flow meter will be compared against the temporary flow meter. The pump should be producing 120 gpm. Electrician should identify if the paddle wheel pulse is relayed to the flow indicator at the "Office" or if the signal is 4-20 ma. Confirm that the output signal at the meter is consistent with the signal at the indicator.
    - These readings will determine whether the pump, flow meter, or both are in need of repair/replacement.
    - Should the flow meter be in need of repair, a replacement paddlewheel style suitable for installation in the existing tee should be sufficient. However, for more reliable readings, a mag meter would be suggested.

3. *" Influent Pump (P1) breaker box needs to be replaced. (breaker will not stay engaged even at proper amperage)."*

    This will be diagnosed when the system is filled with water, the pumps operated, and the diagnostics check out performed.

4. *Influent pump wiring system needs to be checked (P1) at the back of trailer. (float system and wiring for influent pump to surge tank does not function properly).*

    - The floats will require testing when the system is energized.
        - Per the description in the O&M Manual, the Surge Tank is provided two floats. These floats are described to operate P3 only, high-level-on and low-level-off.
        - Operations would make more sense if the high-level float provided shut off to P1 to prevent overflow of the tank. Based upon the labeling of the 220 volt outlet socket believed to be for the Influent Pump P1, it is believed that the operation should be:
            - The high level float is interlocked with the Influent P1 to shut off P1 when high level float makes. This will only work if P1 is plugged into the identified outlet at the rear, right side of the trailer.
            - The low level float is interlocked with the Pressurization Pump P3 to prevent operation of the pump when water level in the Surge Tank is low.
            - Electrician will need to energize system and manually activate floats to determine if proper signal is being relayed when floats activate and deactivate.
            - During this effort, condition of the floats themselves will be checked to assure they are not cracked or otherwise damaged and not operating properly (See Item #8 on June 2011 sheet).
    - Recommendation for system upgrade would be to remove the floats and install a level transmitter (ultrasonic or pressure transmitter for conversion to level). The actual level would then be used to operate both the Influent Pump P1 and the Pressurization Pump P3 with off/on at differing levels to prevent unnecessary cycling of pumps.

5. *"Backup influent pump needs repair (Does not turn when powered up)."*

    Recommendation is to locate pump and determine if impeller spins or if the pump may be frozen up from corrosion. If the impeller spins freely, electrician should power up and check operation. If pump does not function, perform electrical diagnostics and/or replace pump.

6. *"Surge Tank valve and piping to Boost Pump (Pressurization Pump P3) needs to be replaced. (Threads on piping and valve are corroded, unable to thread new fittings in properly)"*

    The piping referred to is located at the bottom of the Surge Tank. The tank is provided a 2" PVC bulkhead fitting with a short nipple and threaded 2"-90º elbow, followed by nipple, gate valve and quick connect. The problem is that the elbow, some nipples, and valve are steel and do show visible signs of corrosion. The bulkhead is close to the floor and the fittings have been threaded. In the current configuration, the components cannot be unthreaded from the tank due to interference from the floor.

    Recommendation is to cut the nipple that threads into the bulkhead fitting. **The nipple should be cut as close to the elbow as possible to provide a stub to place a pipe wrench on.** The stub of the nipple should be unthreaded from the bulkhead.

    A new threaded nipple should be installed, followed immediately with a threaded true union. From there the remainder of the components can be assembled and then connected at the true union.

7. *"Effluent Flow Meter & Totalizer do not function properly."*

    The effluent flow meter is a Signet Scientific paddle wheel style, Model MK575 inserted in the special tee for paddlewheel flow meters. The pipe is 2" PVC schedule 80. The meter is installed on horizontal pipe where full flow in the pipe is consistent.

The effluent line also includes a Hersey non-resettable mechanical flow meter which provides totalized flow. This totalizer is located in the same horizontal line as the Signet effluent flow meter.

Test out of these meters is recommended. Testing to check accuracy should utilize the same clamp on flow meter as recommended for the test out of the flow meter on the backwash pump discharge. By placing the clamp on meter on the vertical upward segment of the effluent discharge line, after the totalizer and flow meter, both the flow meter and totalizer can be simultaneously verified against the clamp on meter.

In the event the existing flow meter or totalizer is found to not be operating properly, it is recommended that they be removed and replaced by a single unit. The existing units would be removed and a straight length of pipe inserted in their place. The replacement flow meter can be a paddlewheel style if desired, or upgraded to a mag meter style and installation is recommended in the vertical upward pipe to provide the straight length required (particularly important for the paddlewheel style and lesser importance for the mag meter). Any unit installed at this location can be provided with a pulse or 4-20 ma signal back to the existing flow meter at the "Office" as well as a local flow and totalizer reading at the meter location.

In the event the effluent flow meter and the backwash flow meter are replaced with pulse style flow meters, the pulse style analog flow indicators at the "Office" can remain. In the event the meters are upgraded to 4-20 ma signal, the analog flow indicators can either be provided a pulse to 4-20 ma converter or replaced with a digital indicator that accepts the 4-20 ma input.

8. *"Additional Items from June 2011 Issues in Springfield Belle Start-up"*

Item 1. The logbook states that the lag filter was taken off-line because carbon was found to be leaching into the final effluent.- Initial review of the log book does not state that this problem was fixed. Further investigation confirmed that on June 29, 2011 that the diffuser at the bottom of this unit was replaced. The diffusers at the bottom of the vessesls (sand, clay and carbon) have perforations for the flow of water. Should these become cracked or broken, the media can work its way into the discharge. As a result, the diffusers can be provided a sock wrap to prevent the filter media migration. Care must also be exercised when placing the filter media. Common practice is to provide a water blanket over the diffusers to reduce the impact of the media being poured in from the top and causing diffuser damage.

Item 2. The Surge Tank was left with 100+ gallons of water/sludge mixture that needed to be pumped, vacuumed and pressure washed. - EQ will revise the O&M Manual to include check in and out procedure that will include an inspection log checklist to prevent further reoccurrence.
Item 3. The boost pump appeared to have a new motor but it was not hooked up and there were no fittings. - When the SB is energized and system is set up for temporary recirculation of water for test out purposes the all pumps should be tested. The external Influent Pump P1should be plugged into the outlet in the rear, right side of the trailer that are marked for use with the float. P1 should deliver 50 gpm at 80' TDH (34.7 psi) minimum. The operation of each of the electrical boost pumps should be tested and those pumps not operating properly, identified for diagnostics. The flow rates as indicated on the flow meter between the bag filter housings and the Surge Tank should be used to observe and record the flows obtained from the pump(s). The Pressurization Pump P3 should also be tested in conjunction with proper operation, designed to provide 50 gpm at 115 feet TDH (49.8 psi) and the float level switches in the Surge Tank.

Item 4. The sock filters were full of water and contained dirty bags. The housings were corroded since water was left in them and needed to be wire brushed. - See response to Item 2. The bag filter housings however are made of ferrous metal, which rusts. It should be expected that the interior of the housings would develop a layer of scale, even after cleaning and drying.

Item 5. The lag vessel lid was not bolted down and fell off during transit. The PVC outlet broke when it fell and hit the floor of the trailer. - Visual observation indicated that these fittings may have been replaced. This area should be checked from leaks when the system is checked out for process flow and

backwash flow operations. Should leaks be detected, the components should be replaced.

Item 6. The "Little Belle" parts and supply trailer was not organized. - Again, see response to Item 2.

Item 7. Several gauges were broken and not functional. - The review did not reveal any gauges that visually appeared to be non-functional. The gauges will require checking when the system is energized and tested out.

Item 8. The floats controlling the pump to the surge tank were cracked and not functioning. - See Item # 4 above in the August 12, 2011 list.

3. Review the system to determine best method for providing recycle water loop for system test out purposes.

The test out of the system can be performed in three stages. The process test out takes into account that the system has been properly wired and energized by a qualified electrician per the requirement identified in the O&M Manual.

Prior to initiation of the testing, the fittings on the bottom outlet of the Surge Tank should be replaced as indicated above.

Stage 1. Test Out, Influent System. Designed to test out the P1 Influent pump(s), bag filter housing, flow meter into the Surge Tank, and operation of the P1 pump with the floats in the Surge Tank. The Influent P1 requirements are not listed in the O&M Manual. However, given that the system is designed for 50 gpm and the flow will be processed through potentially two sets of bag filters for the operation at Portage Creek, P1 should provide 50 gpm at a minimum of 80'TDH (35 psi).

Utilizing one of the 250 gallon or so, low profile plastic tanks that are present in the Hammond office warehouse, fill the plastic tank with water. Insert the P1 Influent pump, plug the pump into the outlet in the SB and operate the pump. Pump should push water through the bag filter housing (check each housing, fittings and gauges individually), through the influent flow meter, and into the Surge Tank. A hook or other devise can be used to lift the high level float in the Surge Tank to see if the Influent Pump P1 turns off/on when the floats are activated/deactivated.

While the level in the Surge Tank is below the low level float, attempt to operate the Pressurization Pump P3 (assure the hose from the Surge Tank bottom discharge to the P3 suction is connected and the P3 discharge is connected to the rigid discharge piping). Until the water level reaches the low level float, P3 should not operate. When water level in Surge Tank does reach the low level float, and the pump should operate, immediately turn off the pump until the second stage of test out is ready to begin.

Observe the operation of the two floats in the Surge Tank when the water level reaches the float level, assure that they float properly (it is possible they are cracked and do float) and that the relays actually relay the signal.

Once the operation of the Pressurization Pump P3 is determined, the effluent line of the Surge Tank can be temporarily routed to return to the plastic tank serving as the sump. The recirculation can continue while water is continuously added into the sump tank and pumped into the Surge Tank until the Surge Tank and the sump tank are full.

Stage 2. Test Out, Process. Designed to test out the Pressurization Pump P3, sand filter housing, organo-clay filter housing, lead-lag carbon filter housings and discharge flow meters.

Prior to initiating Stage 2, assure the following:

- The temporary clamp on flow meter is installed in the vertical upward 2" PVC pipe just after the existing totalizer and flow meter.
- The hose connection from the Surge Tank outlet to the P3 suction should be installed.
- The hose connection from the P3 discharge to the rigid piping should be installed.
- The piping configuration through the valve assemblies should be such that flow is as follows:
    - Sand filter (top entry, bottom discharge)
    - Organo Clay (top entry, bottom discharge)
    - Lead Adsorber (top entry, bottom discharge)
    - Lag Adsorber (top entry, bottom discharge)
    - From the Lag Adsorber to the Backwash Tank until the Backwash Tank is full.
    - Once the Backwash Tank becomes full, a temporary hose from the treated water effluent line at the rear of the SB trailer can be routed to the sump tank or back into the Surge Tank.
- All above tanks and Backwash Tank are full of water and air is removed from tanks.

Once the Surge Tank is full and the steps above are complete, energize P3. Check the electrical conditions to P3. Determine if P3 is energizing and operating. Observe the flow through the vessels and through the existing flow totalizer, flow meter and the clamp on flow meter/totalizer. Verify 50 gpm flow at 115' TDH (49.8 psi). If these conditions are not met, consider diagostics on the wiring, pump and/or pump replacement. If the clamp on meter and the permanent meters do not coincide, consider change out of the existing meters to a mag meter.

Observe and document any location where leaks are identified and where pressure gauges appear to not be operating properly. Repair/replace locations where leaks are observed or gauges not operating properly.

Allow the SB system to operate in process mode for a minimum of half an hour to allow system to flush and check for leaks and proper operation.

Temporarily shut off P3. Reverse the direction of flow through the two Carbon Adsorbers so that the lag vessel becomes lead and the lead vessel becomes lag. Operate the system for a few minutes to assure proper operation.

Stage 3. Test Out, Backwash. Designed to test out the Backwash Pump, backwash flow of the sand filter housing, lead-lag carbon filter housings and backwash flow meter and pressure gauge.

Prior to initiating Stage 3, assure the following:

- The temporary clamp on flow meter is installed in the horizontal 3" PVC pipe just after the existing flow meter in the backwash supply line. Assure that the clamp on flow meter settings are established for pipe conditions.
- Temporarily set up the backwash flow to return directly to the Backwash Tank to recirculate flow for the backwash test out. This can be accomplished by:
    - Remove the blind flange on the Backwash outlet line and install a temporary quick connect.
    - Connect the temporary hose to the Backwash Tank inlet.
- Follow O&M Manual procedures for backwashing of the sand filter housing and the Lead and Lag Adsorber housing individually.

Turn on the Backwash Pump and observe:

- Backwash pump operation (electrician to check voltage, current, amperage) and determine if pump is operating within specification. 120 gpm at 40' TDH (17.3 psi).

- Discharge Pressure.
- Flow rate on the Signet flow meter (electrician to check signal at flow meter and indicator during operation).
- Flow rate on the clamp on flow meter.

Test each housing individually, checking flow at both flow meters and pressure for each housing tested.

At the completion of Stage 3 testing, the water should remain in the tanks until any repairs that are deemed necessary are completed and the unit can be retested.

At the completion of all testing and retesting, the temporary lines are to be removed and the permanent lines replaced.

Vessels should be drained and dried prior to closing.

4. Review the system to see if any upgrades could be recommended for:

a. **Improvements for overall operations.**
b. **Make the SB suitable for use at Portage Creek for treatment of accumulated water on the soil staging pad.**

a. Improvements for Overall Operations.

One of the most difficult functions of an operator is to manually balance out the flow of pumps that are aligned in series. Typically this is performed utilizing throttling valves, which produces unnecessary wear on the pumps. The pumps on the SB system also pump water through filters that eventually become increasingly blocked with solids. As the pump is fixed speed, and the valve is throttled, the flow rate decreases due to the blockage and the pumps require more manual throttling (valve opening) in order to allow more flow. A better approach would be to place the Influent Pump P1 and the Pressurization Pump P3 on Variable Frequency Drives (VFD) and providing a flow meter on the discharge of each pump to regulate the flow at a consistent rate. As a result, the flow from P1 in to the Surge Tank would remain consistent and the flow out of the Surge Tank and through the treatment process would also remain consistent at the same rate. This is important in that the flow remains constant, regardless of the pressure differential that begins to develop across the filters. As the backpressure increases, the VFD increases the speed of the pump to maintain the target flow rate. This also removes doubt of the pressure differential across any one filter because the flow remains the same and the filter drop is more accurate.

To facilitate this change, the Influent Pump P1 and the Pressurization Pump P3 will require a VFD and a mag flow meter with 4-20 ma output on the pump discharge. The flow signal from each flow meter will be transmitted to an operator interface panel where the flow rate for the system will be manually input (target). The flow meter for each pump will transmit the instantaneous flow rate to the controller. The controller will compare the actual flow rate with the target flow rate. The controller will then ramp up or down the VFD for the pump in order to bring the instantaneous flow rate in line with the target flow rate.

The pumps would also remain interlocked with high and low level floats in the Surge Tank to prevent over filling or operation of pumps with low feed water levels.

The operator will remain responsible for the overall flow rate and the differential pressure across each filter, providing backwash when the differential pressure reaches the specified differential pressure for that unit.

As mentioned above, replacement of the floats in the Surge Tank with an actual level transmitter (ultrasonic or pressure) will provide more complete control of the Influent Pump P1 and the Pressurization Pump P3 to

prevent overflowing of the Surge Tank, operation of P3 at low tank levels, and better control to reduce on/off cycling of either pump.

b. Make the SB suitable for use at Portage Creek for treatment of accumulated water on the soil staging pad.

The SB will treat accumulated water from the soil staging pad. This will be free water that has drained from the soils as well as precipitation. Any removal of solids from entering the sump of the pad will beneficial in the overall operation of the SB system. It is recommended that the flow be filtered through straw bales and silt curtain prior to entering the sump.

Water from the sump pad will be pumped over to a holding tank. The holding tank requirements will be established based on the amount of free water runoff and precipitation and may vary over the seasons. It is recommended that temporary storage tanks such as Baker Tanks or equivalent be on standby for delivery in short order. Sufficient tankage should be provided to allow settling of transferred solids from the staging pad sump as well as hold the backwash water and allow the resulting solids to settle. One tank in overflow mode into a second tank used for pump out into the system should suffice.

The treatment process is recommended to filter the suspended solids to 5 micron prior to the clay or carbon filters. As a result, a duplex filter housing similar to the one installed in the SB is recommended. The first set of filter housing will be provided 20 micron nominally rated filter bags and the second set of housings will be provide 3 – 5 micron nominally rated filter bags. The micron rating on the first set of bags can be adjusted to provide for balanced removal of suspended solids between the first and second set of bags. The first set of bags can be made of low cost material. The second set of bags can be provided as polypropylene which has an affinity to adsorb trace quantities of oil in the flow stream.

If the filter bags are provided as described above, the sand filter will most likely not be necessary. This will eliminate the need for sand filter media, backwashing, and spent media disposal.

The Organo-Clay and Carbon Adsorbers will both be used and the backwash frequency should be reduced if the filtration ahead of the adsorbers is provided as described above.

An additional set of duplex bag filters is recommended after the carbon adsorbers. This set of bags should be in the 1 micron nominal range and provided to capture any residual carbon fines that may leach from the carbon beds.

The carbon has an affinity to adsorb oxygen from the water. The Michigan DNR may require re-oxygenation of the water prior to discharge to the receiving stream. In the event this is required, the discharge line from the 1 micron bag filters can be routed to a cascading stair step configuration to provide a tortuous path, splashing environment that aerates the water. This will only be installed if directed.

As a result, the process recommended includes:

- Filtration of staging pad run off water as it flows into the pad sump.
- Sump pump to transfer collected water to Holding Tank. Holding tank to be a single frac tank, operated to draw from the mid-level. The lower portion of the tank will serve as solids settling. The upper half of the tank will provide for flow equalization and spent backwash storage capacity.
- Holding Tank with Influent Pump P1 on high-level float control in Surge Tank.
- 20 micron duplex bag filters.
- 5 micron duplex bag filters
- Surge Tank with Pressurization Pump P3 on low-level float control in Surge Tank.
- Organo-Clay filtration

- Lead Carbon Filtration.
- Lag Carbon Filtration.
- 1 micron duplex bag filters.
- Cascade aerator for re-oxygenating, if required.